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PERSONAL CONTACTS.

In a world where rapid progress is the order of the day, in agriculture as in other branches of human activity, the need for the co-ordination of knowledge will be generally admitted. For tropical agriculture such a service already exists, since much knowledge is being disseminated through the medium of Imperial Bureaux, publications and correspondence, and of personal visits throughout the Colonial Empire by senior officers attached to various British institutions. By such means a constant flow of information has been maintained from the colonies to the United Kingdom and *vice versa*. Valuable as this amassing and publication of information has proved to be there is a feeling abroad that its utility can be greatly increased by personal contacts between those responsible for the organisation and conduct of agricultural affairs.

The matter has been considered for some time. Prominence was given to the subject of the interchange of workers at the Imperial Agricultural Research Conference in 1927. At the time three possibilities were considered: firstly, visits by senior officers to other parts of the Empire to familiarize themselves with the progress of research and the development of technique in their own special subjects or subjects connected with them; secondly, attendance at Research Institutes by comparatively junior officers on study leave; and thirdly, interchange for fairly long periods between workers who become members of the staff of the institution into which they are "interchanged". In the first category may be included experienced officers who have been selected by institutions in the United Kingdom to pay special visits to the Colonial Empire. Considerable benefits have been derived from such visits in so far as they have served to link up various activities in the colonies with those of institutions in the United Kingdom. The question of study leave is one that concerns all Departments of Agriculture. Study leave undoubtedly offers one of the best opportunities for acquainting officers with new developments of research, and also for establishing personal contacts between the staffs of Colonial and British institutions. It may be noted in passing that certain Colonial Agricultural Departments, notably the Gold Coast, have already taken advantage of the study leave facilities which are provided in the form of refresher

courses at the Imperial College of Tropical Agriculture. The third possibility probably offers the greatest opportunities in the tropical colonies.

The position of the College in regard to these matters may be considered. As an institution it is peculiarly placed since it possesses both research and teaching facilities. It has already derived great benefits from tours paid by members of its staff to other parts of the tropics. Such tours inevitably yield much useful material for research purposes while the officers concerned are not only stimulated by their experiences but also able to supply helpful advice wherever they go. There is considerable scope for the arrangement of further tours, especially when the Imperial aspects of the cacao and banana research programmes are taken into consideration. The College has in turn benefited from visits of experienced officers attached to other institutions. Among these may be included the Agricultural Adviser to the Colonial Office, the Secretary to the Horace Plunkett Foundation, the Economic Botanist from Kew, two research workers from the London School of Tropical Medicine and Hygiene, two entomologists from Fiji and many others from foreign Institutes as well as from other parts of the British Empire.

In respect of study leave the College has through its refresher courses already welcomed experienced officers from several Departments of Agriculture, notably the Gold Coast. This scheme has two-fold advantages : on the one hand the officers attending the courses benefit from their period of training at the College and from a complete change of environment, and on the other, the teaching staff has secured from time to time some useful knowledge in regard to the type of training required by such officers. As a result of this, and also of information received from past students situated in many parts of the Colonial Empire, it has been possible to modify the programme of lectures in relation to the particular needs of future agricultural officers. From the point of view of the College departments themselves study leave also offers attractive advantages.

Turning to the question of the interchange of officers there can be no doubt as to the benefits, both from the research and teaching aspects, which would be derived from a more general development of this system. Several members of the College Staff have had previous experience of other parts of the Colonial Empire, but there are others whose services have been confined to the West Indies, who would benefit from visits to other parts of the tropics. The advantages to be gained from such visits have already been stressed in respect of research. From the teaching point of view there would be ample scope for securing a good deal of first-hand information in regard to the more important characteristics and problems of agricultural industries in the colonies visited, and of studying, in particular, the organisation of Colonial Departments of Agriculture. To illustrate this, reference may be made to the first interchange of senior officers which was recently effected by the College with the Gold Coast Department of Agriculture. In this case advice was given by the College officer on agricultural economic problems in general and Co-operation in particular in the Gold Coast. Much valuable information on agricultural conditions in West Africa generally has been brought back to the College and useful contacts have been established with the staffs of the West African Departments of Agriculture. Considerable material has been collected for teaching purposes and several films of various West African agricultural industries are now available at this institution. The visiting officer, on the other hand, made himself thoroughly familiar with the teaching and research activities of the College and with agricultural conditions in Trinidad, Tobago and Grenada. From a financial point of view the experiment was particularly advantageous since it involved little extra expenditure on the part of the institutions to which the officers belonged.

An early opportunity will, it is hoped, be given to other senior members of the staff to make use of the exceptional facilities and advantages which such an interchange offers. Consideration will be given to the suggestions put forward at the Imperial Agricultural Research Conference that the larger institutions might be prepared always to have at least one member of their staff serving in another part of the Empire and a member of another institution taking his place. The main difficulties of the system lie in the question as to whether the senior officer who is interchanged can be spared for as long as a year. The release of such a senior officer from the College might involve some interruption of the research work of the department concerned, but the teaching activities could proceed without interruption with the assistance of the visiting officer. In the case of the exchange with the Gold Coast arrangements were successfully made to overcome these difficulties, and to leave the visiting officer with adequate time to examine agricultural industries, and to familiarise himself with the efforts made by planters, Departments of Agriculture and the College to overcome many and diverse agricultural problems. There is no reason to suppose that other departments would present difficulties which could not similarly be overcome. One of the main functions of the College is to keep in close touch with new developments of research in tropical agriculture. There is no better way of achieving this object than by encouraging the establishment of personal contacts through the exchange of officers.

THE EDITOR requests that any subscriber who fails to receive *Tropical Agriculture* regularly should communicate with him immediately in order that the matter may be rectified.

ON THE VIABILITY OF CACAO SEEDS AFTER STORAGE.

By E. E. Pyke, E. R. Leonard and C. W. Wardlaw.

(*With the extension of research in cacao problems the need has arisen for transporting pods over long distances, the pods to be maintained in such condition that the seeds not only remain viable but are also capable of germinating and becoming thoroughly established as seedlings. The following investigations were carried out in collaboration between the Cacao Physiologist and the Officers of the College Low Temperature Station.*)

Introduction.

According to information received from Mr. S. F. Ashby, Imperial Mycological Institute, cacao seeds (from pods smeared with carbolated vaseline and with carbolated vaseline and solid paraffin) germinated readily after a storage period of 15 days, but failed to germinate when the storage period was extended to 30 or more days, even though they still appeared normal and viable. To quote Mr. Ashby, "It would appear that a pronounced lessening of vitality occurs after two to three weeks associated with oss of resistance to rotting organisms. One of the pods, however, in the sending inspected on 6th October, 1933, was kept in the cool shed unopened until 1st November, 1933 (40 days from picking); at the end of this period the beans were still of normal hue in section and apparently alive but failed to germinate". From the information available it may be accepted that time, temperature and fungal factors are operative in determining the viability of cacao seeds. With a view to obtaining more precise data the following investigations were undertaken.

Treatment of Pods.

A random collection of freshly picked pods (from River Estate) was separated into lots of three pods each and exposed at temperatures of 80° F., 70° F., 60° F., 50° F. and 45° F. for periods of 10, 20, 30, 40 and 50 days. Other lots, of two each, were held at 80° F. and 70° F. respectively after having been subjected to the following treatments:—

1. Smeared with carbolated (5 per cent.) vaseline.
2. Soaked for 15 minutes in 0.2 per cent. Mercuric Chloride, then smeared with carbolated vaseline.
3. Soaked for 15 minutes in 3 per cent. formalin, then smeared with carbolated vaseline.
4. Soaked for 15 minutes in 0.2 per cent. Mercuric Chloride solution, then covered with two coatings of latex solution.

In order to test the efficacy of the disease-control methods adopted, the fruits for the disinfectant treatments above were selected from those pods which showed signs of cuts or abrasions sustained during reaping and transport. In each of the treatments, including untreated controls, lots of two pods were selected and weighed periodically throughout the storage period. In a second series the carbolated vaseline applied contained only 2½ per cent. phenol, and some pods, soaked in mercuric chloride solution and formalin respectively were smeared with pure vaseline.

Loss in Weight at Different Temperatures and with Different Treatments.

Table I shows the percentage loss in weight sustained by random samples of untreated (control) pods held at 80° F., 70° F., 60° F. and 50° F. respectively.

Table I.

Temperature. °F.	% Relative Humidity (approx.).	Weight of one fruit in grammes.	Percentage Loss in Weight after				
			10 days.	20 days.	30 days.	40 days.	50 days.
80	50-95	584.5	23.9	45.8	64.1	77.9	80.8
70	80	556.3	11.2	22.8	39.6	58.2	70.2
60	80-85	588.5	9.2	17.3	23.8	33.3	44.4
50	80-85	537.8	7.2	13.9	21.0	31.9	42.2

Remarks.—In respect of loss in weight during storage, cacao pods behave like other vegetable commodities in that desiccation proceeds much more rapidly at the higher temperatures. Even after 20 days at 80° F. when pods have lost 40 to 50 per cent. by weight, the seeds, though somewhat dry are still apparently normal and viable.

Table II and Table III show the percentage loss in weight at 80° F. and 70° F. respectively in pods protected by different treatments, with untreated controls for comparison.

Table II.—(First Series.)

Temp.	Treatment.	Average Weight of one fruit in grammes.	Percentage Loss in Weight after				
			10 days.	20 days.	30 days.	40 days.	50 days.
80° F.	1. Carb. vas.	632.7	3.5	14.0	29.6	51.0	65.4
	2. $HgCl_2$+Carb. vas.	629.7	2.6	8.6	16.5	28.7	41.5
	3. Formalin+Carb. vas.	459.2	4.0	24.0	47.7	70.4	77.4
	4. $HgCl_2$+Latex	601.7	10.0	26.1	43.1	63.6	75.4
	5. Control (untreated)	584.5	23.9	45.8	64.1	77.9	80.8
70° F.	6. Carb. vas.	522.2	1.5	4.2	8.4	16.3	29.2
	7. $HgCl_2$+Carb. vas.	488.7	1.0	3.1	7.7	15.7	25.1
	8. Formalin+Carb. vas.	564.2	2.4	10.8	27.7	48.2	65.2
	9. $HgCl_2$+Latex	608.2	4.3	8.8	12.7	19.4	29.6
	10. Control (untreated)	556.3	11.2	22.8	39.6	58.2	70.2

Observations on 20th Day. 1.—Both rotted; 2.—1 sound, 1 partly rotted; 3.—1 severely rotted, 1 less rotted; 4.—1 sound, 1 rotted; 5.—1 desiccated, 2 rotted; 6.—Both sound except for a small rotted patch in one; 7.—1 sound, 1 slightly rotted; 8.—Both slightly rotted; 9.—Both sound; 10.—1 partly rotted, 2 sound.

Table III.—(Second Series.)

Temp.	Treatment.	Average Weight of one fruit in grammes.	Percentage Loss in Weight after				
			10 days.	20 days.	30 days.	40 days.	50 days.
80° F.	1. Carb. vas.	858.0	5.0	14.6	34.9	56.3	72.5
	2. $HgCl_2$+Carb. vas.	619.5	2.5	4.5	6.6	10.0	17.1
	3. Formalin+Carb. vas.	581.2	3.9	9.0	25.5	48.3	64.9
	4. Formalin+pure vas.	584.0	1.3	6.3	20.3	39.7	51.3
	5. $HgCl_2$+pure vas.	538.0	2.4	5.4	15.9	41.1	59.8
	6. Control (untreated)	566.7	26.0	48.3*	—	63.4	78.4
70° F.	7. Carb. vas.	739.0	2.8	5.3	10.1	20.7	36.3
	8. $HgCl_2$+Carb. vas.	442.2	1.3	2.3	4.2	9.8	18.0
	9. Formalin+Carb. vas.	517.5	2.7	4.8	10.1	20.2	32.3
	10. Formalin+pure vas.	567.2	1.3	4.7	13.0	25.4	39.0
	11. HgCl2+ pure vas.	503.7	1.2	2.0	4.4	11.7	23.4
	12. Control (untreated)	635.7	14.5	28.6†	51.7	68.5	76.2

* Desiccated. † Both rotted.

REMARKS.

It might have been anticipated that at any one temperature all pods smeared with vaseline would have shown approximately the same percentage loss in weight. In spite of the fact that pods had been steeped in disinfectant solutions and then smeared with carbolated vaseline, fungal wastage in some pods was in evidence from the tenth day onwards. With further storage this became increasingly accentuated. The exploitation of pod tissue by active parasites like *Botryodiplodia theobromae* and *Gloeosporium luxificum* is without doubt mainly responsible for the variability in loss of weight recorded (*see* footnotes to Table II). Where rotting was slight the vaselined pods compare very favourably with untreated pods in respect of moisture conservation, especially at 70° F. In sound specimens held at 70° F. the vaselined pods appeared practically unchanged from the time of harvesting.

Fungal Wastage.

At the higher temperatures (70° F. and 80° F. respectively) fungal wastage becomes conspicuous between the tenth and twentieth day in storage and thereafter increases rapidly in intensity. Thus although pods examined on the tenth day showed external blemishes, there was no evidence that hyphae had penetrated through the pod or become established in the mucilage surrounding the beans. By the twentieth day, however, some pods—especially those which had been subject to mechanical injury—were severely rotted, the hyphae of *Botryodiplodia theobromae* having formed a weft round the beans, so that the mucilage was more or less completely destroyed. The beans on sectioning, however, appeared normal and uninjured. Such effects were intensified in pods examined after 30 days in storage. Again, although *B. theobromae* was conspicuous in the mucilage, the beans appeared quite normal.

It is to be noted that in pods bruised or injured during harvesting and transport, or in which sub-epidermal, latent or dormant infections had been established previously, no effective control of fungal wastage was obtained by any of the several disinfectant treatments applied. The smearing with vaseline is therefore chiefly useful in the prevention of excessive desiccation. *B. theobromae* Pat., a rapidly growing wound parasite, was the principal source of wastage. In the pods examined it was frequently observed causing extensive superficial blemishes or a spreading stem-end rot. This organism rapidly penetrates through the pod tissue and subsequently destroys the mucilage round the beans.

Colletotrichum luxificum Van Hall & Drost. This fungus causes sunken, spreading blemishes which later become covered with pink acervuli. The fungus slowly rots its way through the pod, causing a localised browning of the tissues. Within the moist pod cavity, an abundant aerial mycelium and spore beds may be produced. The mucilage is apparently affected only to a slight extent. Other fungi observed included *Colletotrichum Cradwickii* Banc., *Gloeosporium* sp. and *Aspergillus* sp.

The extensiveness of fungal rotting after relatively short storage periods and the fact that the several organisms cannot apparently be sufficiently controlled by the application of fungicides or by temperature, point to the need for most careful handling of pods during harvesting, transport and storage. Penetration appeared to be considerably more frequent at the stem end that at lateral infections.

Germination.

At the end of each storage period the beans from each pod of each treatment were examined, samples being cut open to note the effect of the treatments on radicles and cotyledons. The beans were sown in sand and kept in a warm greenhouse, of mean day temperature 85° F., with light watering. They were examined for germination after seven days, it having been found by previous trials that with healthy, fresh beans practically complete germination had taken place within six to seven days at this temperature. The "effective germination" was assessed by counting the number of seedlings that had broken surface and remained alive three to four weeks after sowing. The results of these initial and final germination counts are presented in Tables IV and V. The variability was high both in the incidence of fungal wastage in the individual pods, and also in the germination shown by the samples of beans. In view of this variability much larger samples of pods would be required to form an estimate of the relative values of the different antiseptic treatments, and hence attention is drawn only to the comparative results at the four temperatures, 50° F., 60° F., 70° F., and laboratory temperature (mean diurnal 80° F., mean maximum 85° F., mean minimum 78° F.), and to the relative values of vaseline and latex, against untreated controls respectively, as moisture conservors.

REMARKS.

In pods held at 45° F. and 50° F. for ten days, some abnormal colouring appeared on the pods (*e.g.*, yellow became tawny yellow to dingy brown) and the beans within showed unmistakable signs of chilling, the cotyledons being brown almost to the centre. The radicles, on the other hand, appeared healthy, and the surrounding mucilage seemed normal and fresh. Beans held at 45° F. for ten days showed no signs of germination, whereas those held at 50° F. gave ten per cent. germination after seven days, but died when the radicle had protruded a few mm., so that the effective germination was nil. Incipient germination was still in evidence after 30 days, but again there was no subsequent viability. Pods held at these low temperatures for longer periods became decidedly discoloured, frequently blackened, and the beans brown and non-viable.

GERMINATION PERCENTAGE AT 60° F.

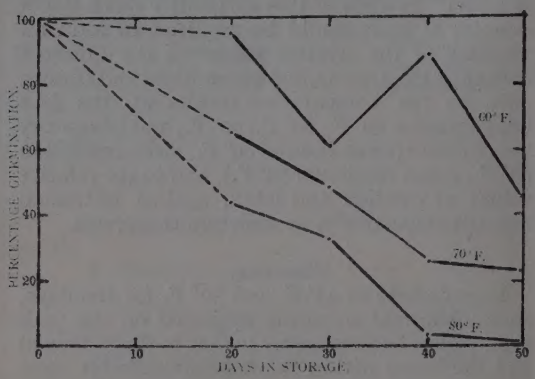
Untreated pods only were used at this temperature. Except for slight but progressive shrivelling, the pods appeared fresh up to 30 days and the beans were entirely fresh in appearance and smell, and gave very good germination and vigorous seedlings. By 40 days the pods had fairly extensive fungal infections and slight penetration of the cavity but the beans appeared to be unaffected, and gave very good germination. By 50 days the fungal attack had progressed and in some of the pods there was a weft of mycelium on the beans. Germination tests on the least affected and the more heavily affected beans were made separately, the respective percentages being (59, 61 and 29, 26). Thus a rapid decline was evident at this time, although by using an anti-desiccation treatment, preservation for another 10 or 20 days might be possible.

I F I F*

GERMINATION PERCENTAGE AT 70° F.

(*a*) *Control.*—Effective germination was fairly good up to 30 days, but after that fell off rapidly, the causes probably being the combined effect of desiccation and fungal attacks.

(*b*) *Vaseline treatments.*—The weight records show (*see* graphs) that smearing with carbolated vaseline was very effective in reducing loss of weight of the pods, both when used alone or combined with previous steeping in antiseptics. Thus individual pods that escaped extensive or deep fungal infections, gave beans of normal fresh appearance, smell, and germinating power, even after 50 days.



(*c*) *Latex treatment.*—This treatment (after a mercuric chloride steep) was effective in reducing water loss: this result, however, is not in conformity with other experience. Germination was fair up to 40 days.

GERMINATION PERCENTAGE AT 80° F.

Laboratory storage: Throughout this paper "80 F." is used for convenience to denote storage at laboratory temperature.

(*a*) *Control.*—Germination was fair up to 20 days but beyond that time was negligible.

(*b*) *Vaseline treatments.*—As at 70° F., smearing with vaseline was very effective in reducing loss of weight, provided extensive fungal attack did not develop. By contrast with the 70° F. trial, however, the combined treatment of mercuric chloride steep and carbolated vaseline was very much more effective than the simple carbolated vaseline, or the other combined treatments, in reducing loss of weight. This was not correlated however, with any definite increase of germination power, although unfortunately the $HgCl_2$ 30 days sample of experiment 1 almost certainly owed its low germination to the inclusion of abnormal pods containing a high proportion of sterile beans. Taking the two experiments, and all the vaseline treatments, collectively, germination was still good at 30 days, and a few pods gave fairly good germination after 40 days. At 50 days, however, beans which were perfectly fresh in appearance failed to germinate well, so that a deterioration was evident apart from that caused by desiccation and fungal attack.

Recommendations.

1. *Collection of Pods.*

Since antiseptic treatments do not materially check the development of latent or incipient infections, it is important scrupulously to examine the pods for even minute blemishes, particularly in the depression at the junction of the pod and the stem, and to reject all pods showing such blemishes. Although the condition of maturity of the pods was not included in the scope of the experiments, general experience would suggest collecting the pods just before they are fully ripe as indicated by the change of colour, in order to obtain the best germination.

2. *Antiseptic Treatment and Packing.*

A thin, but even coat of white vaseline, with or without 2½ per cent. carbolic acid is recommended to preserve the pods from water loss. To the same end steeping for 15 minutes in a 0.2 per cent. solution of mercuric chloride before smearing with vaseline would appear to be efficacious. The pods should be wrapped in grease-proof paper or cellophane, and packed closely to avoid bruising.

3. *Storage Temperature.*

When available, temperatures between 60° F. and 70° F. should be used. This is the temperature range normally provided by a well insulated, small domestic ice chest in the tropics, when supplied with about 10 lb. of ice daily. Chilling below 60° F. even for short periods is harmful, so that in cold weather pods should be kept warm.

4. *Size of Sample Consignments.*

Although the approximate storage temperature has now been ascertained, the unpredictable onset of fungal wastage and the consequent variability in seed germination make it imperative that individual samples should consist of not less than five and preferably of ten pods to avoid disappointment.

* *I*—Initial germination
F—Final germination and establishment.

Table IV.

FIRST EXPERIMENT—PERCENTAGE GERMINATIONS.

EXPERIMENT 1.		10 DAYS.				20 DAYS.				30 DAYS.				40 DAYS.				50 DAYS.			
Temp.	Treatment.	*I*	*F*	*I*	*F*	*I*	*F*	*I*	*F*	*I*	*F*	*I*	*F*	*I*	*F*	*I*	*F*	*I*	*F*	*I*	*F*
		Good.		Bad.		Good.		Bad.		Good.		Bad.		Good.		Bad.		Good.		Bad.	
80° F.	Control	84	91	—	—	84	69	—	—	0	0	—	—	0	0	—	—	0	0	—	—
	Carb. vas.	—	—	—	—	74	49	—	—	3	0	—	—	10	0	0	0	0	0	—	—
	$HgCl_2$ + carb. vas.	—	—	—	—	69	48	—	—	17	5	—	—	0	0	0	0	27	2	—	—
	Formalin + carb. vas.	—	—	—	—	58	14	—	—	37	32	—	—	41	21	—	—	0	0	—	—
	$HgCl_2$ + latex	—	—	—	—	30	0	—	—	0	0	0	0	0	0	0	0	0	0	—	—
70° F.	Control	92	94	—	—	52	54	—	—	53	45	—	—	68	68	0	0	0	0	—	—
	Carb. vas.	—	—	—	—	73	40	—	—	24	1	—	—	70	36	19	4	17	7	3	3
	$HgCl_2$ + carb. vas.	—	—	—	—	94	94	—	—	94	58	—	—	5	5	50	42	11	51	2	0
	Formalin + carb. vas.	—	—	—	—	14	38	—	—	81	47	—	—	61	48	—	—	17	14	0	0
	$HgCl_2$ + latex	—	—	—	—	76	71	—	—	57	30	—	—	44	44	—	—	0	0	—	—
60° F.	Control	55	71	—	—	87	96	—	—	100	61	—	—	90	89	—	—	59	61	29	26
50° F.	Control	10	0	—	—	4	0	—	—	10	0	—	—	0	0	—	—	0	0	—	—
45° F.	Control	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Table V.

SECOND EXPERIMENT.—PERCENTAGE GERMINATIONS.

EXPERIMENT 2.		10 DAYS.				20 DAYS.				30 DAYS.				40 DAYS.				50 DAYS.			
Temp.	Treatment.	*I*	*F*	*I*	*F*	*I*	*F*	*I*	*F*	*I*	*F*	*I*	*F*	*I*	*F*	*I*	*F*	*I*	*F*	*I*	*F*
		Good.		Bad.		Good.		Bad.		Good.		Bad.		Good.		Bad.		Good.		Bad.	
80°F.	Control	—	—	—	—	27	33	—	—	11	7	—	—	0	0	0	0	decaye	d and	not pl	anted
	Carb. vas.	—	—	—	—	60	53	—	—	98	75	100	85	34	29	0	0	0	0	—	—
	$HgCl_2$ + carb. vas.	—	—	—	—	86	17	—	—	100	95	55	49	72	21	0	0	13	6	—	—
	Formalin + carb. vas.	—	—	—	—	74	74	—	—	54	36	69	88	not rec		orded		0	0	—	—
	$HgCl_2$ + ord. vas.	—	—	—	—	90	88	—	—	40	39	—	—	39	9	0	0	0	0	—	—
	Formalin + ord. vas.	—	—	—	—	65	21	—	—	12	0	7	3	0	0	0	0	5	0	—	—
70°F.	Control	—	—	—	—	81	60	—	—	76	76	3	3	3	0	—	—	decaye	d and	not pl	anted.
	Carb. vas.	—	—	—	—	71	54	—	—	68	56	60	41	18	11	0	0	64	59	29	26
	$HgCl_2$ + carb. vas	—	—	—	—	91	68	—	—	82	70	—	—	50	37	—	—	69	59	0	0
	Formalin + carb. vas.	—	—	—	—	62	79	—	—	95	32	81	65	57	38	17	14	84	68	65	60
	$HgCl_2$ + ord. vas.	—	—	—	—	92	91	—	—	90	86	—	—	81	60	—	—	31	20	—	—
	Formalin + ord. vas.	—	—	—	—	77	77	—	—	88	44	91	87	32	18	—	—	0	0	74	62

I—Initial=6 days. *F*—Final=3 to 4 weeks.

LOCUSTS IN NIGERIA.

By F. D. Golding, M.A., F.R.E.S.

Introduction.

During the last four years swarms of four species of locusts have been recorded in Nigeria, *viz.*: the Migratory Locust, *Locusta migratoria migratorioides*, R. & F.; the Red Locust, *Nomadacris septemfasciata*, Serv.; the Desert Locust, *Schistocerca gregaria*, Forsk.; and the Tree Locust *Anacridium moestum melanorhodon*, Walk. Of these the Migratory Locust was the only species of major importance.

Although swarms were reported in many years between 1890 and 1929—the year in which the *Locusta* outbreak began in Nigeria—it seems certain that the last occasion on which there was a general infestation of Nigeria was at the end of the 19th century. The outbreak appears to have lasted for about seven years and there is no doubt that *L.m. migratorioides* was the species concerned.

In recent years abundant evidence has been forthcoming to substantiate the locust phase theory first formulated by Uvarov in 1921 (1). The solitary phases of most species of locusts are now well-known. In several instances the transition from the solitary to the gregarious phase has been observed in the field and transition in the reverse direction has often been witnessed. The formation of swarms can only be effected in certain areas which have been designated "reservations" by Uvarov (2). At present little is known of the nature of the ecological changes which initiate the production of phase *gregaria* from phase *solitaria*. Zolotarevsky (3 & 4) has found that swarm formation of *Locusta migratoria capito*, Sauss. in Madagascar is due to the crowding of solitary individuals in isolated humid areas during the dry season.

It was soon realised that, provided the reservations of the various species could be located in future years control could probably be effected by preventing the formation of swarms in these areas. In Nigeria the shore of Lake Chad was suspected of being a reservation of the Migratory and Red Locusts. In 1931 the writer made a preliminary survey of the shore and, during the first six months of 1933, he carried out an ecological survey at Kalkala, a village at the south-western corner of Chad. The ecological study is now being continued by Mr. A. M. Gwynn, a former student of the Imperial College of Tropical Agriculture.

The main objects of the present paper are to give a short account of the bionomics of the various species of locusts in Nigeria and to describe the means of control employed during the last four years.

The Migratory Locust.

The present outbreak of *Locusta* seems to have originated in the Middle Niger region (French Sudan) in 1928 (5). Several swarms of an unidentified species were present in this country between September and November, 1929; but the main infestation did not begin until early December, when *Locusta* swarms entered the south-western corner of Nigeria from Dahomey. The swarms spread northwards and eastwards and, by the end of April, 1930, some had reached the northern frontier of Nigeria. Breeding occurred between March and July in the south-west and in the Northern Provinces. Most of the daughter swarms, derived from hopper bands which had escaped destruction during the locust campaign, migrated to the north-east. These second generation adults bred between August and December and a southern migration of third generation swarms began in October. A few swarms had reached the Southern Provinces by the end of October. In each year since 1930 there has been a movement of swarms to the north in the spring and a return migration southwards in the autumn. Two generations of hoppers have been present in each year in the Northern Provinces; but very few bands have appeared in the south since 1930. A curious feature of the swarm movements is the invasion of the south-western corner of Nigeria from Dahomey on three occasions since December, 1929. In April, 1932, a few swarms entered the south-west corner about three weeks after the normal spring evacuation of the Southern Provinces was completed. Again, in November, 1932, and December, 1933, swarms invaded the south-western area from Dahomey before the normal autumn migration from the North had reached the Southern Provinces. Between October and June the prevailing wind is south-westerly at Pobé, a village in southern Dahomey near the Nigerian frontier. This would account for the swarms entering Nigeria, but the writer is unable to explain why swarms should be as far south as the 7th parallel in Dahomey at a time when no swarm in Nigeria was south of the 9th parallel. The swarms which entered south-western Nigeria in early November, 1932, had crossed the south of Dahomey from west to east a few days before.

At the time of writing (April, 1934) there are fewer flying swarms present in Nigeria than there have been in the spring of any year since the infestation began. In addition, the autumn hopper outbreak of 1933 was the smallest recorded; in parts of the Northern Provinces oviposition took place, but no hoppers emerged. The rains ended exceptionally early and there seems no doubt that this was the factor responsible for the diminution in the number of swarms of the autumn generation. It is not yet certain whether there may be an embryonic diapause during the dry season; but it is hoped that definite evidence on this point will be obtained in the near future as egg-laying areas in the Zaria Province, from which no hoppers hatched, have been demarcated and are being kept under observation. There have been many reports of hoppers appearing in the spring in areas said

not to have been visited by flying swarms for some months; but, on examining the records, the writer found that, in every instance except one, swarms had been reported from the vicinity a few weeks before eclosion took place.

During the four years of the outbreak about 900 samples of swarms have been received from all parts of Nigeria and have been examined biometrically. The fore-wings of the swarming phase are relatively longer and the hind femora relatively shorter than those of the solitary and intermediate phases, so the ratio length of fore-wing : length of hind femur forms a valuable guide as to whether an outbreak is beginning to abate. The results of the biometrical examination of swarm samples are shown in Table I; the first swarms to invade Nigeria are thought to have belonged to the fourth generation of adults since the beginning of swarming in the Middle Niger region in 1928 (5) and are therefore described as F4.

Table I.

	Generation.	Average Length.		Ratio. $\frac{W}{H.F.}$	No. of specimens measured.	No. of swarms represented.
		Hind femur.	Wing.			
			Males.			
		mm.	mm.			
1929-30 ..	F. 4	23.0	49.7	2.17	37	16
1930 ..	F. 5	23.2	51.8	2.23	206	88
1930-31 ..	F. 6	22.6	49.0	2.17	150	59
1931 ..	F. 7.	21.8	46.8	2.14	52	20
1931-32 ..	F. 8.	22.6	48.7	2.15	135	47
1932 ..	F. 9.	22.1	47.3	2.14	33	13
1932-33 ..	F. 10	22.5	47.9	2.13	20	11
1933 ..	F. 11.	23.5	48.7	2.07	4	2
1933-34 ..	F. 12.	22.7	48.0	2.11	21	8
			Females.			
		mm.	mm.			
	F. 4.	24.2	52.9	2.19	50	12
	F. 5.	24.1	55.3	2.21	246	91
	F. 6.	23.6	51.9	2.20	157	62
	F. 7.	22.5	49.8	2.21	55	22
	F. 8.	24.2	51.1	2.11	150	48
	F. 9.	22.8	50.2	2.20	33	15
	F. 10.	23.5	50.7	2.16	27	10
	F. 11.	23.9	52.1	2.18	5	2
	F. 12.	23.7	51.4	2.17	22	8

The number of specimens examined is small, but the results of the examination indicate a tendency or the wing : hind femur ratio to decrease.

The average wing : femur ratios of solitary phase individuals taken near Lake Chad in 1933 were 1.82 for 28 males and 1.83 for 25 females.

Hopper Incidence.

An examination of the locust records of the eleven Northern Provinces was made with the object of determining the approximate dates on which hoppers were first reported in each province in the spring and autumn from 1930 to 1933. In most instances the sequence of events was remarkably uniform. The approximate dates of the appearance of hoppers and the geographical positions of the various provinces are shown in Table II.

Table II.

Province.	Geographical position.	Date of Appearance of Hoppers.			
		1930.	1931.	1932.	1933.
		Spring Infestation.			
Kabba	Between 7°N. & 8° 30′N.	April 26	April 20	April 19	May 12
Benue	7°N. & 9° N	April 14	Mar. 30	Mar. 22	Mar. 1
Adamawa ..	7°N. & 11°N.	April 12	April 25	April 26	May 3
Ilorin	8°N. & 11°N.	April 20	May 15	May 28	June 3
Plateau ..	8°30′ N. & 10°N.	April 24	May 1	April 28	April 12
Niger	8°30′ N. & 11°N.	April 28	April 25	April 15	May 2
Bauchi ..	9°30′N. & 12°30′N.	May 8	May 4	May 17	May 2
Zaria	9°30′N. & 13°N.	May 16	May 24	May 12	May 5
Bornu	10°N. & 13°30′N.	May 20	May 16	May 17	June 12
Kano	11°N. & 13°N.	May 31	May 10	May 21	May 22
Sokoto	11°N. & 13°30′N.	May 22	April 27	May 21	May 27
		Autumn Infestation.			
Bornu	—	Aug. 19	Sept. 15	Sept. 14	Aug. 15
Kano	—	Sept. 6	Sept. 28	Sept. 17	Sept. 28
Zaria	—	Sept. 4	Sept. 27	Oct. 29	Sept. 23
Sokoto	—	Sept. 30	Sept. 29	Sept. 24	Sept. 23
Bauchi ..	..	Sept. 10	Oct. 5	Oct. 8	Sept. 25
Adamawa ..	—	Sept. 22	Oct. 8	Oct. 24	Oct. 12
Plateau ..	—	Oct. 16	Oct. 22	Nov. 18	None.
Niger	—	Oct. 14	Oct. 29	None	Oct. 27
Ilorin	—	Oct. 21	Dec. 9	None	None.
Benue and Kabba	—	Dec. 23 & 27	None.	None	None.

It should be mentioned that, occasionally, one or two hopper bands appeared in a province some weeks before the beginning of the general infestation; bands of this type are not included in Table II. The autumn infestation in the Bornu Province sometimes follows so closely after the spring hopper outbreak that it is difficult to differentiate between the two; further, the presence of Red Locust bands in the Chad area from July to September each year added to the difficulty of determining the dates on which *Locusta* hoppers of the autumn generation were first reported.

From Table II it will be seen that hatching usually does not begin until after the end of April in areas north of 9° 30′ N.; whereas hoppers of the autumn generation usually hatch before the end of September in those areas. In 1930, adults of the spring generation first appeared in early May

(in the Southern Provinces) while in the following year they did not appear until early June; it will be noticed that the autumn breeding season of 1931 began several weeks later in most provinces as a result of this difference in the time of final ecdydsis.

The Red Locust.

In Nigeria *Nomadacris* is at present confined to the coastal strip in the southern half of British Chad. The adult stage lasts from early October to July, hatching takes place in late July or early August. Hoppers were very abundant in 1930 and 1931 and many bands were destroyed by the numerous European anti-locust officers, who were present in the Chad area in those years. It seems not improbable that the Chad area is a reservation of this species and that the energetic measures taken in 1930 and 1931 prevented an outbreak of the swarming phase.

The adults spend the dry season in tall grass, *Cymbopogon giganteus* and *Echinochloa pyramidalis*, in which they are, to some extent, safe from attacks of predaceous birds. In April and May they gradually spread from the tall grass habitats on to farmland and short grass areas where breeding takes place. The writer is of the opinion that British Chad is not a reservation of *Locusta* (6). This species lives chiefly in the short grass habitats from February to May and is controlled by bush fires and the Carmine Bee-eater which follows man, cattle and antelopes in order to catch the grass-hoppers disturbed by their progress through the grass. These birds were present in numbers in the ecological survey area throughout the dry season and were observed to destroy considerable numbers of non-gregarious *Locusta*, which had become extremely rare by the end of May—at which time the first swarm appeared from the South. Although large numbers of *Nomadacris* adults were killed by these birds and the Cattle Egret, their preference for tall grass habitats proved to be a valuable protection for the majority of the locusts.

Nomadacris is now swarming over a large part of Africa south of the equator.

The Desert Locust.

The first definite record of this species in Nigeria was in January, 1929, when a large swarm was seen flying north-westwards over the Benue Province. In April and May, 1931, swarms entered the Sokoto, Zaria and Kano Provinces from the north and proceeded eastwards across the northern part of Nigeria. There is no evidence that this species breeds in this country. The writer found a few individuals in the northern part of British Chad in October, 1931.

The Tree Locust.

There are only two definite records of the occurrence of swarms of *Anacridium* in this country. A swarm was seen near Sokoto in January, 1933, and another about 80 miles to the south-west of that town in February, 1934. There is no evidence that the Tree Locust has been responsible for any considerable damage to crops in Nigeria. *Anacridium* is common on Acacias in British Chad, but no signs of the formation of swarms have been observed in that area.

The Campaign against *Locusta*.

The appearance of numerous swarms of *Locusta* in December, 1929, was entirely unexpected and there was some doubt as to whether breeding was likely to take place in this country. It must be remembered that when the previous large scale outbreak was in progress Rabeh was ravaging the area which is now the Bornu Province and that the British occupation did not reach as far north as the 10th parallel.

At the end of March hoppers were reported from Iseyin in the Oyo Province and, during the following month, numerous bands appeared elsewhere in that province and in the Abeokuta and Benue Provinces. A curious feature of the infestation in the forested parts of the south-western area was the tendency of the bands to migrate along the Nigerian Railway and the roads. Many bands coalesced and, on the railway, one composite band was said to have been about 20 miles in length and some 30 yards in width. Trains squashed hoppers on the rails, which became so greasy that the wheels slipped and the trains could not proceed. A locust train was assembled and the bands were effectively sprayed with sodium arsenite solution. Bands off the railway were destroyed by means of trenches and pits, into which the hoppers were guided by means of V-shaped wings of corrugated iron, or by driving them into heaps of dried grass which were then fired.

In mid-April the writer proceeded to Yandev, an agricultural station about 50 miles south-east of Makurdi in the Benue Province. Shortly after his arrival a band of hoppers, 80 acres in area, hatched and, two days later, began to migrate south-westwards on a front three-quarters of a mile in width. No corrugated iron was available and only 40 labourers could be procured. The writer, a colleague and these 40 Munshis worked from dawn to dusk digging trenches in front of the band and destroying it section by section. After several days an administrative officer arrived with 300 more Munshis and the band which had then divided into three sections, was destroyed by a circle of men—armed with branches—driving the hoppers towards the centre and then beating them to death. It was found that if the men were encouraged to sing their tribal songs the beating became rhythmic and far more effective. After a particularly efficient battue it was the custom of the Munshis to give a royal salute which consisted of a rush towards the Europeans at the end of which they formed into three ranks, the first kneeling, the second bending forward and the third standing upright—each man holding his branch over his head.

It is worth recording that a curious optical delusion resulted from the spending of twelve hours daily amongst a mass of moving hoppers. On

returning to the rest house in the evening the bare soil surrounding it appeared to be covered with migrating hoppers. The delusion was so convincing that it was some time before it was realised that there was, in fact, not a single hopper in the vicinity of the house.

In 1930 there was a strong prejudice against the use of poisoned bait because most races in Nigeria regard adult locusts as a culinary delicacy and many look upon hoppers as a welcome addition to their diet. In August of that year the poisoned bait method was used in the Chad area without any fatalities to man or stock and, a few months later, preparations were made for the general use of bait in the 1931 spring campaign. The bait consists of 30 lb. of base (usually bran or sawdust) mixed with a solution of 12 oz. of sodium arsenite in 8 gallons of water. This mixture is scattered amongst and around the hoppers in the early morning or evening when they are quiescent. In 1931 alone 31 tons 5 cwt. of sodium arsenite were used in the Northern Provinces and, at a rough estimate 150,000 acres of hoppers were destroyed by all methods.

In the extreme north it was found necessary to double the quantity of poison in the bait because the higher ground temperatures in the morning caused the hoppers to begin their migration earlier and the period of feeding on the baited area was therefore reduced.

Flame-throwers and sodium fluosilicate were found to be too costly and there seems no doubt that sodium arsenite bait is the most effective method of controlling hoppers. Provided care is exercised there is little danger to man or stock.

In 1930 and 1931 an agricultural officer was attached to each infested province as locust adviser and many European officers were seconded from nearly every Government department to supervise the manufacture and application of bait. Since then the organisation of the campaign has been handed over to the Administrative department. The number of Europeans available for locust work is now much smaller, but there are many Africans thoroughly conversant with the method of applying bait to hopper bands.

Except in isolated areas the damage to crops has at no time been considerable. The writer believes that this satisfactory state of affairs is due to the energy and enthusiasm displayed by the numerous officers who have taken part in the campaigns of the last four years. Nigeria is fortunate in possessing a large population and comparatively few unpopulated areas in which locusts can breed without being discovered or disturbed.

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RECENT FINE CHEMICALS: HORMONES AND VITAMINS.

Among the latest applications of biochemistry to the fine chemical industry is the technical production of insulin from pancreas. Insulin is a hormone secretion which enables the animal organism to deal with glucose sugar. The daily human requirement is about five milligrams. Shortage of insulin is a cause of diabetes, and a great number of sufferers from this complaint are nowadays kept alive by administered doses of this commercially-manufactured hormone. Another important hormone is thyreo-globulin, secreted by the thyroid gland. It promotes oxidative changes in the animal body. Only about one milligram per day of this substance is needed by the human subject. It owes its activity to its iodine-containing derivative, thyroxine, whose composition has recently been discovered by chemists. Thyroxine may now be produced synthetically at a cost lower than that of thyroid extract. Similarly, adrenalin, another active hormone which produces the reactions accompanying the emotions of fright, anger and danger, has also been synthesised and subjected to successful large-scale manufacture.

Among the vitamins or essential food accessory substances, Vitamin D can now be made and sold at such a price that the human daily requirement (0.05 milligram) costs less than one-tenth of a penny. Vitamin D promotes the absorption of calcium and of phosphate from the intestine into the blood; hence it is sometimes called "calciferol". Finally, Vitamin C, the food accessory that prevents scurvy, has been recently synthesised and put on the market in relatively large quantities. Chemically speaking, it is the simplest of the vitamins. The first plant material successfully employed for its isolation was the orange; Szent-Györgyi, in 1928, used 5,000 oranges for preparing a minute quantity of Vitamin C or "ascorbic acid", as it is often called. Since 1932, red peppers (*Capsicum*) have proved to be a much better source of Vitamin C, and the employment of peppers on a large scale led directly to the final elucidation of its chemical constitution (3-keto-*l*-gulonolactone) and its synthesis.—(*Nature*, 21st July, 1934, No. 3377.)

MANURIAL EXPERIMENTS WITH COCONUTS ON PERSEVERANCE ESTATE, COUVA.

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Introduction.

In December, 1931, a series of experiments was planned with the object of trying to ascertain the probable cause of the Wilt Disease of Coconuts. One of these experiments consisted of fertiliser trials to test whether the disease was in anyway related to a deficiency of some nutritive substance in the soil. It was expected that, from the crop records, useful information might also be obtained on the manuring of coconuts.

The field selected for the experiment is known as No. 1 Felicité Hall. Previous to 1913, this field was planted in sugar-cane, and in that year coconut plants were planted through the canes, 24 feet apart, one row in each bed, 22 feet wide. Coconuts and canes were grown together for five to six years.

Coconut Wilt appeared in the north-western section of the field in 1928, extending eastward and gradually spreading to the northern half of the field, but there were no wilted trees in the southern half when the plots were marked out in December, 1930.

Lay out.—The plots were laid out in the south-eastern corner of the field. There are four blocks or replicates of nine random plots. A plot consists of two beds with three trees in each or six trees. An 18-inch drain separates one bed from the next, and the blocks are separated from one another by a guard row of trees. The soil is an acidic loamy-silt.

Treatments.—The treatments comprise a complete fertiliser consisting of 2 cwt. sulphate of ammonia, 5 cwt. superphosphate of lime and 2 cwt. sulphate of potash, also pulverised limestone, applied alone and in combination with the NPK fertiliser as follows :—

Treatments per Acre.

T_0. No treatment—Control plot.
T_1. 9 cwt. complete fertiliser.
T_2. 18 cwt. do do
T_3. 10 tons pulverised limestone.
T_4. 20 tons do do
T_5. 9 cwt. complete fertiliser + 10 tons pulverised limestone.
T_6. 18 cwt. do do + 10 tons do do
T_7. 9 cwt. do do + 20 tons do do
T_8. 18 cwt. do do + 20 tons do do

The limestone was applied in April, 1931, and the artificials in July, 1931 and May, 1933.

Yield Data.—The number of nuts reaped for each plot has been recorded from 1st January, 1931.

Results.

The yield in nuts per tree for 1931 is given in Table I.

Table I.
Yield in Nuts per Tree 1931.

	T_1.	T_2.	T_3.	T_4.	T_5.	T_6.	T_7.	T_8.	T_0.
A	22	21	27	24	25	22	22	25	13
B	23	34	28	34	16	22	37	19	24
C	40	19	27	29	34	34	17	31	17
D	16	22	21	34	26	18	27	15	36
Totals	101	96	103	121	101	96	103	90	90

The Analysis of Variance shows that no differential effect ascribable to treatments can be detected.

Table II.
Analysis of Variance of Yields in 1931.

Due to	DF	Sum of Squares.	Mean Square.
Blocks	3	149.86	49.95
Treatments	8	173.22	21.65
Error	24	1,383.89	57.66
Total	35	1,706.97	

The conclusions to be drawn are, that during the seven months after the manures were applied, there was not sufficient nutrients absorbed by the trees to show any definite increase in yield. That there is some effect is probable since the control plot total yields average least over the block, but the large tree-to-tree variabilty obscures any effect due to manures applied.

Table III.
Yield in Nuts per Tree 1932.

	T_1.	T_2.	T_3.	T_4.	T_5.	T_6.	T_7.	T_8.	T_0.
	39	40	49	31	33	31	46	33	17
	46	35	50	61	35	31	45	38	36
	53	37	26	45	56	36	34	42	22
	14	20	20	36	47	32	31	27	38
Totals	152	132	145	173	171	130	156	140	113

It is evident that natural yields in 1932 were altogether greater than in 1931, but it is significant that the average yield for the control plots is now less than that of any treated plot. T4, which gave the outstanding yields in 1931, is again the highest yielding treatment, and the yield is now more than 50 per cent. greater than that of the controls. There is very little consistency, however, about plot yields, and the Analysis of Variance shows that, although 'treatments' now account for a much larger fraction of the total sum of squares of plot deviations from the mean, the Treatment Variance is still less than that which is unexplained.

Table IV.

ANALYSIS OF VARIANCE OF YIELDS IN 1932.

Due to	DF	Sum of Squares.	Mean Square.
Blocks	3	775.56	258.52
Treatments	8	766.89	95.86
Error	24	2,556.44	106.52
Total	35	4,098.89	

The Tree-to-Tree Variance is so large that even the large increase in yield of Treatment 4 cannot be judged significant. At the same time, it is evident that the yields of the treated plots are drawing further away from those of the controls.

Table V.

YIELD IN NUTS PER TREE 1933.

	T_1.	T_2.	T_3.	T_4.	T_5.	T_6.	T_7.	T_8.	T_0
	74	72	54	57	65	71	83	58	28
	77	61	80	70	89	76	83	76	50
	90	66	54	70	86	92	67	81	40
	48	69	33	64	67	69	52	81	42
Totals	289	268	221	261	307	308	285	296	160

It will be noticed that in 1933 the general yields are greater than in 1932. The totals for Treatments 5 and 6 have now passed the total for Treatment 4 and show a yield of 90 per cent. above that of controls.

The Analysis of Variance shows that the variance due to treatments is now appreciably greater than that unexplained, which indicates that some treatments at least have had an effect on yield.

Table VI.

ANALYSIS OF VARIANCE OF YIELDS IN 1933.

Due to	DF	Sum of Squares.	Mean Square.	$\frac{1}{2}\log_e$ Mean Square.
Blocks	3	1,446.97	482.32	
Treatments	8	4,631.22	578.90	3.1806
Error	24	2,838.78	118.28	2.3866
Total	35	8,916.97		

The treatments, however, consist of a complete series of interactions between lime and artificials and the Variance of 578.90 can be further split up as follows to show the effect of each treatment.

Thus treatment yields may be analysed as follows :—

Table VII.

		Quantities of Lime.			
		0	10	20	Totals.
Quantities of Artificials	0	160	221	261	642
	9	289	307	285	881
	18	268	308	296	872
Totals		717	836	842	

showing an Analysis of Treatment Variance in Table VIII.

Table VIII.

ANALYSIS OF VARIANCE OF TREATMENTS IN 1933.

Due to	DF	Sum of Squares.	Mean Square.	$\frac{1}{2}\log_e$ Mean Square.
Quantities of Artificials	2	3,058.5	1,529.25	3.66623
Quantities of Lime	2	828.5	414.25	3.01324
Interactions	4	744.25	186.00	2.61288
Total	8	4,631.25		

The Complete Analysis of Variance table is as follows :—

Table IX.

Due to	DF	Sum of Squares.	Mean Square.	$\frac{1}{2}\log_e$ Mean Square.	Diffs.
Blocks	3	1,446.97	482.32		
Quantities of Artificials	2	3,058.5	1,529.25	3.66623	1.27962
Quantities of Lime	2	828.5	414.25	3.01324	.62663
Interactions	4	744.25	186.00		
Error	24	2,838.78	118.28	2.38661	
Total	35	8,916.97			

For P = .05 Z = 0.6030
For P = .01 Z = 0.8481

Thus applications of artificials have given a significant increase in yield which would occur by chance less than once in 100 trials, and lime has given a significant increase which would occur by chance less than once in 20 trials. The interaction of lime and artificials has had no effect over and above that of the components themselves.

Table X sets forth the Mean yield in nuts for 1933 for the lime and artificials treatments respectively.

Table X.

MEAN YIELD OF NUTS PER TREE IN 1933.

	Per acre.			
All plots	No lime	59.75	Diff.	
do	10 tons lime	69.67	9.92	Diff.
do	20 tons lime	70.17	10.42	0.50
do	No artificials	53.50	Diff.	
do	9 cwt. artificials	73.42	19.92	Diff.
do	18 cwt. artificials	72.67	19.17	− 0.75

The Standard Error of difference between any two treatment means $= \sqrt{\frac{118.28 \times 2}{12}}$ or 4.44 nuts per tree.

For P = .05, t = 2.064. A significant difference between mean plot treatment yields must exceed 2.064 × 4.44 = 9.16 nuts per tree, and this result would be due to chance less than once in 20 trials.

For P = .01, t = 2.797. A difference which would be due to chance less than once in 100 trials must therefore exceed 2.797 × 4.44 = 12.42 nuts per tree.

It is thus evident that 10 tons of lime per acre is as efficient as 20 tons; and 9 cwt. of mixed artificials is as efficient as twice that quantity. The actual increase in yield through applying 9 cwt. artificials per acre is approximately twice that obtained by applying 10 tons lime, namely, nearly 20 nuts per tree. The mean yield of plots obtaining both lime and artificials is 74.75 nuts per tree compared with 40 nuts per tree for the control plot, which is in agreement with the expected increase from the table above.

The Use of Previous Records.

It is often possible with perennial crops to subtract from the general variability of the yields an amount which is due possibly to the inherent genetic differences in the trees, and to increase the precision of the results of an experimental year using the yields of a year prior to the experiment as 'natural yield' records.

In this way it was thought that, if the 1931 yields were considered as natural yields (the manures were proved to have no effect), and were used to increase the precision in analysing the 1932 yields, some differences in 1932 might show up as significant.

That the precision of the analysis can be increased in this way, as suggested by Sanders (1), is shown by the table below.

Table XI.

	Random Variance.	Covariance with 1931.	Vy.x.	Relative Precision.
1932	106.52	—	106.52	1.000
1931	57.66	47.28	70.69	1.507

The Analysis of Variance then appears as follows :—

Table XII.

Due to	DF	Sum of Squares.	Mean Square.
Blocks	3	518.63	
Treatments	8	417.91	52.24
Error	23	1,626.16	70.70
Total	34	2,562.70	

The variance due to error has been reduced from 106.52 to 70.70, which is approximately equivalent to expectation. Treatment Variance, however, has been reduced a corresponding amount, which goes to prove that, in 1932, there was no real effect due to the manures.

Since, by correcting the yields of 1932 by those of 1931, the precision of the results improves considerably, it may be possible by treating the 1933 yields in the same manner to demonstrate greater precision here also.

The Covariance in this case amounts to 25.84 so that

$$\text{Vy. x} = \left\{ 118.28 - \frac{(25.84)^2}{57.60} \right\} \frac{24}{23} \text{ or } 111.34.$$

The Table of Relative Precision is thus

	Random Variance.	Covariance with 1931.	Vy.x.	Relative Precision.
1933	118.28	—	118.28	1.000
1931	57.66	25.84	111.34	1.062

There is a slight increase in precision but not sufficient to cause any change in the results as they stand.

Conclusions.

The experiment demonstrates that the yield of coconuts may be increased under the conditions of Felicité Hall both by the application of lime and by the application of mixed fertilisers. It is significant that 10 tons of lime and 9 cwt. of artificials per acre give as large an increase as double those quantities. Further, both lime and artificials cause their respective increases in yield entirely independently of one another. In neither case, for mature coconuts, does an increase in yield manifest itself until two years after application.

Acknowledgment.

The writer wishes to convey his thanks to Mr. F. J. Pound for his interest and the valuable assistance given in interpreting the results.

Reference.

(1) Sanders, H.—The Use of Previous Records in Uniformity Trials. *Journ. of Agric. Science*, 29 (1930), 63.

TWO CASES OF LINKAGE IN NEW WORLD COTTONS.

By S. C. Harland.

(*Empire Cotton Growing Corporation, Cotton Research Station, Trinidad, B.W.I.*)

Introduction.

During the past eight years much information has been obtained respecting the hereditary behaviour of characters in New World cottons. About thirty factors at eighteen different loci have been established to exhibit simple monohybrid inheritance, and the linkage relationships of most of the loci have been studied. Practically all genes exhibited free association but two cases of relatively close linkage have been encountered. In view of the large number of chromosomes (n=26) in New World Cottons it seems desirable to place the facts with regard to these on record.

Linkage between Green Lint G^l and Crinkled c^r.

As previously pointed out by the writer (1929) and Ware (1933) green and white lint form an allelomorphic pair of characters in Upland cottons (*G. hirsutum* L.) and may be represented as $G^l - g^l$.

The type known as "Crinkled Dwarf" occurs rather frequently as a mutant in Sea Island, *G. barbadense* L. and has been recorded also in Egyptian cotton under the name "Wrinkled leaf". In crosses with Upland cotton crinkled dwarf exhibited blending inheritance (Harland, 1929). By repeated back-crossing of heterozygotes to Upland, the type of segregation ultimately resolved itself into one of simple monohybrid relationship, and it became possible to investigate the linkage relationships of the crinkled gene (c^r) to known Upland genes. Crinkled proved to be linked with green lint as follows :—

Table 1.

Linkage relationship between Green lint and Crinkled in the back-cross $[G^l C^r \times g^l c^r] \times g^l c^r$.

Normal green.	*Normal white.*	*Crinkled green.*	*Crinkled white.*
80	7	1	71

Cross-overs=5 per cent.

The genes for green lint and crinkled are thus about 5 units apart on the chromosome.

Linkage between Red R^l and Cluster habit c^l.

Thadani (1923) found a linkage between the red coloration of certain types of Upland, and the cluster habit. In F_2 of the cross Red Cluster by green normal he obtained the following numbers :—

Red Normal.	*Red Cluster.*	*Green Normal.*	*Green Cluster.*
136	48	73	0

It will be seen that no cross-overs appeared in Thadani's experiments. The writer has studied a cross in which linkage and not repulsion is expected. The results are as follows :—

Table 2.

Linkage relationship between Red and Cluster in the back-cross [RC^l (red normal) $\times$ rc^l (green cluster)] $\times$ rc^l (green cluster).

Red Normal.	*Red Cluster.*	*Green Normal.*	*Green Cluster.*
231	36	39	234

Cross-overs=13.9 per cent.

Discussion.

Hitherto, although it has proved possible to transfer single genes from Upland to Sea Island-Egyptian and vice versa, the prospects of synthesising for example a type of Upland with Egyptian quality lint have appeared somewhat remote. The genetical make-up of the two species *G. hirsutum* (Upland) and *G. barbadense* (Sea Island-Egyptian) is apparently so different that crosses between them result in mutual disintegration of the co-ordinated systems of modifier complexes which have become different in the two species through long continued geographical isolation. As more cases of relatively close linkage are discovered in the New World group it will become possible to transfer definite chromosome sections from one species to another, and much important information of economic value may result.

Will, for example, the transference from Upland to Egyptian or vice versa of the 13 unit section between Red and Cluster, result in the simultaneous transference of any genes of economic importance? Experiments on these lines will form the subject of future investigation.

References.

Harland, S. C. (1929).—"The Genetics of Gossypium." *Bibliographia Genetica* 9 : 107-182.

Thadani, K. I. (1923).—"Linkage Relations in the Cotton Plant." *Agr. Jour. India.* 18 : 572-579.

Ware, J. O. (1932).—"Inheritance of lint colours in Upland Cotton." *Jour. Am. Soc. Agron.* 24 : 550-562.

AGRICULTURAL NOTE BOOK.

Copies of Professor Wood's "Note-Book of Tropical Agriculture" (price 5 shillings) may be obtained on application to the Editor, *Tropical Agriculture*, Imperial College of Tropical Agriculture, Trinidad, B.W.I.

THE DUTCH LEEWARD ISLANDS.

By H. A. Ballou.

(I) General Features.

The Dutch possessions in Tropical America include Surinam* in South America, and two groups of small islands in the Caribbean. These island groups are Curaçao, Bonaire and Aruba off the coast of Venezuela, and St. Eustatius, Saba and St. Martin in the Northern Leeward Islands. St. Martin is owned partly by the French and partly by the Dutch Governments. The three Dutch Leeward Islands, together with the French island of St. Bartholomew, lie between St. Kitts and Anguilla, the northernmost of the British Leeward Islands. Curaçao (which is the headquarters of the Dutch West Indian Islands), is separated from its Leeward Island dependencies by a distance of some 600 to 700 miles across the eastern Caribbean Sea.

The Dutch Leeward Islands once held an important place in the commercial and agricultural affairs of the West Indies, but, in common with other small West Indian Islands, they have become in recent times of minor importance. They are but little known, being off the usual steamer routes, with little to offer as attractions to tourists. Until recently, they have only been accessible by sailing boats. At the present time, however, there is a regular fortnightly steamship service from Curaçao *via* St. Thomas and the Dutch Islands to St. Kitts. There is also a French service *via* St. Kitts and St. Bartholomew to St. Martin.

The Dutch Leeward Islands are very small in size; their areas and populations, together with mountain heights and rainfalls, are shown in the following table, which includes particulars of other neighbouring islands for comparison.

Island.	Area in sq. miles.	Population.	Height in feet.	Rainfall in inches.
Montserrat	32	12,000	3,000	57
Nevis ..	50	13,000	3,600	52
St. Kitts ..	68	26,000	3,700	60
St. Eustatius	9	1,000	2,000	40
Saba	5	1,200	3,000	40
St. Martin				
French	20	4,000	1,500	40
Dutch	18	2,500	—	—
Anguilla ..	35	4,000	200	36

The rainfall of the Dutch Islands is evidently very low, amounting to about 40 inches per year. There are no streams nor ponds, but the water supply is artificially conserved in cisterns and tanks, and in most years is ample for domestic use and for the maintenance of livestock. Nevertheless, in years of extreme drought, serious water shortages have occurred. The rainfall, as in all the Lesser Antilles, is variable. The wet season generally comprises the five months, July to November, but any of the wet months may be dry, and any of the dry months may be wet.

The following table shows the mean monthly rainfall over a period of ten years at St. Martin, and the extreme maximum and minimum for each month during that period.

St. Martin: Rainfall in Inches.—10-year period, 1919 to 1928.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Average ..	2.16	2.61	1.91	2.41	1.61	2.64	3.22	2.90	5.32	5.24	3.81	2.48
Maximum ..	3.93	4.62	4.75	8.61	5.58	4.77	5.50	16.14	10.93	12.81	10.41	3.72
Minimum ..	1.07	0.71	0.88	0.47	0.12	0.82	1.04	0.83	1.17	2.78	1.21	0.89

(II) Geology and Soils.†

Considered in their geological aspects, Saba and St. Eustatius belong to the Volcanic Group of West Indian Islands, which forms an arc, commencing in the south with Grenada, and ending in the north with St. Kitts, St. Eustatius and Saba. These islands consist of a consolidated basement of old volcanic rocks, probably of Cretaceous or early Tertiary age, covered with layers of much more recent (Pleistocene and Recent) fragmental volcanic material consisting of loose ash, sand, stones and boulders. The mineralogical composition of the volcanic material is that of hypersthene andesite, consisting essentially of the minerals soda-lime felspars, hypersthene (or augite and hornblende), olivine and magnetite. In general, Saba and St. Eustatius appear most closely to resemble St. Kitts and St. Vincent.

* An article on Surinam by C. W. Wardlaw, was published in *Tropical Agriculture* Vol. VII, pp. 31-37, 1930.

† The writer is indebted to Prof. F. Hardy and to Mr. R. A. Hamilton (Post-Graduate Student), of the Imperial College of Tropical Agriculture, for the geological and soil information, based on the partial examination of typical soil samples collected in Saba (3 samples), St. Eustatius (10 samples) and St. Martin (7 samples).

On the other hand, St. Martin belongs to a different geological group, and consists of a basement of ancient consolidated volcanic rocks, covered by water-deposited sediments, comprising aqueous tuffs, cherts and conglomerates, over-lain in turn by massive limestones of Oligocene age. In these respects, St. Martin resembles the eastern part of Guadeloupe, Antigua, St. Bartholomew and Anguilla. In St. Martin, the Oligocene limestones occur mainly in the northern and eastern (French) parts of the island. The southern (Dutch) part apparently consists chiefly of older volcanic rocks, similar to those occurring in the mountainous south-western district of Antigua.

These geological facts are important in comparing the soils of Saba, St. Eustatius and St. Martin, both within themselves, and with those of the British West Indian Islands. Actual microscopic examination of some typical Dutch islands soils showed that the mineral components of the Saba and St. Eustatius soils occur in fresh, only slightly decomposed grains, of which about half consist of soda-lime felspar, and the rest mainly of ferro-magnesian minerals, with little or no magnetite. In these respects they closely resemble the coastal valley soils of St. Vincent. The soils of Dutch St. Martin contain abundant red-coloured ferruginous products of the weathering of ferro-magnesian minerals, together with partly altered, cloudy felspar, and certain fresh minerals, such as secondary chlorite and zircon, not found in the soils of the other two islands.

The soils vary between gravels, sands and sandy-loams. Their reaction is slightly acidic, neutral or quite alkaline. Organic matter is fairly abundant, and the nutrient status is good. Available potash is relatively plentiful, but available phosphate is variable. The St. Martin soils are the least sandy, and contain the least organic matter and phosphate, whilst potash is quite abundant. On the whole, the soils appear to possess high inherent fertility, and not to be in need of manuring. The factor limiting their productivity seems to be rainfall or water supply. They are generally highly permeable, their natural drainage being very free.

(III) Agricultural Features.

(1) *Saba.*—This steeply mountainous island differs agriculturally from all other West Indian areas. There appear to have been no estate cultivations of cotton or sugar-cane within recent years. The arable land occurs as steep hillside gardens, small in area, and suitable only for primitive hand labour. The Saba peasant's hoe has a handle about half the length of the hoe handle used in other islands, and is well adapted for working on steep hillsides. There are no roads suitable for wheeled traffic, and there are no wheeled vehicles in the island. The principal roads are bridle tracks, some three to six feet in width. On the steeper parts of the mountain sides, the tracks are built up in stone steps.

The population is distributed in four villages, the principal of which is called Bottom, situated within an extinct volcanic crater, some 800 or 900 feet above sea level, and about three miles from the rocky landing place. Windward Side, the second village, lies at an altitude of about 1,200 feet, and is about eight miles from Bottom, being reached by a road which passes St. Johns at an altitude of 1,800 feet.

Saba is reputed to have had a boat building industry, the boats being built at Windward Side and lowered down the mountain side into the sea for launching. This story appears to be a myth, although it is a fact that a few years ago a boat was built at Windward Side and carried on men's shoulders to the sea. The men of Saba have always been sailors and sea-faring people. In common with other West Indians, they have sought seasonal employment at the large sugar estates in the Greater Antilles. The population includes a large proportion of whites. The women of Saba do not work the land. They are noted for their needlecraft, and the sale of drawn-thread work or Spanish needlework has been the source of a considerable income to the island.

(2) *St. Eustatius* (or Statia, as it is locally called) is a symmetrical volcanic cône whose lower slopes flatten out near the sea coast. The northern part of the island comprises an elevated plateau having precipitous sea cliffs. The island was one of the chief marketing centres of the West Indies during the eighteenth century. It is said that, when Rodney captured St. Eustatius in 1781, the value of the stores and merchandise commandeered by him approximated three million pounds. The chief coastal town existing in those days is now represented by partly submerged ruins of former buildings situated on a narrow strip of coast land overhung by a sea cliff. The chief town nowadays is Orangestad built on a cliff at an elevation of 200 feet. Almost the entire population of the island is housed in this town.

The old estate buildings are mainly in ruins. The land is divided by wire fences into pastures for grazing stock, whose water supply is provided by wells and tanks. The easily-worked fertile soil is cultivated in patches by peasants, whose gardens produce yams and sweet potatoes, some of which are exported. Cattle and goats also are exported to some extent.

Certain of the broad roads of former times are still maintained in repair, but there are no wheeled vehicles, excepting a Government lorry which is used chiefly in scavenging town refuse.

(3) *St. Martin.*—St. Martin is noted for its salt ponds, which are worked under government concessions. The principal town, Philippsburg, occupies the strip of beach about 100 yards wide and one mile long which separates the Salt Ponds from the bay. The estates which formerly produced cotton and sugar-cane are now given over to the grazing of cattle. No agricultural work is being done in St. Martin, except the cultivation of peasants' gardens, and the growing

of pasture and forage grasses on some of the stock farms. The stock is exported from the French port of Marigot. The largest of the stock farms lies partly in Dutch St. Martin and partly in French territory. Here, an attempt is being made to improve the natural pasturage by introducing new types of grass and forage plants, particularly those resistant to dry conditions, and having high feeding value. The stock is also being graded up by the introduction of thorough bred bulls.

The better soils of this farm are being planted in Guinea Grass. The land is first tilled and cross-tilled by plough and harrow. Manurial experiments are been conducted by the Government in order to determine what are the best manures to use in Guinea Grass cultivation. The surplus grass crop is put up in bales as reserve. Cattle grain foods are also being imported. Although the natural pasture, consisting of small local grasses, is good in reasonably wet seasons, Guinea Grass is recognised as the standard forage, but Elephant Grass, Guatemala Grass, Molasses Grass and Uba Cane are being also tested in plots, both by the Government and by private owners.

(IV) The Cotton Industry of the Dutch Leeward Islands.

Sea Island Cotton was grown in St. Martin and St. Eustatius from about 1904 to 1922. The seed was obtained from the British Islands, and cotton of excellent quality was produced. Most of it was sold in the English markets, along with similar cotton from the British West Indies. The cotton growers of these two islands appear to have been familiar with the cotton pests of the earlier years (the cotton worm, cotton stainers, leaf-blister mite and scale insects), and to have adopted for their control the methods common in the other islands. They seem not to have known anything about the pink bollworm.

The pink bollworm made its appearance in St. Kitts and Montserrat in 1920, and in Anguilla in 1921. In 1922 the cotton crops of St. Martin and St. Eustatius were so poor that none was planted in 1923, nor has any been planted since. It is reasonable to suppose that the pink bollworm invaded the cotton fields of the Dutch islands in 1921 and 1922, but failed to be recognised by the cotton growers. Owing to lack of agricultural supervision, growers allowed their seed supply to become very mixed. Buyers and shippers did not discriminate between good and bad cotton, and shipments from the islands are said to have been penalized for irregular type and for bad preparation generally, with the result that, by 1921, the industry had seriously declined. The crop of 1922 was a complete failure, presumably as a result of invasion by pink bollworm. Whether this presumption is correct or not, it is a fact that no Sea Island cotton has been grown in the Dutch Leeward Islands since 1922.

(V) Other Industries.

There are no satisfactory records of the exports of agricultural produce from St. Martin. At the present time, the livestock is shipped entirely from the French port, Marigot. This comes about from an agreement made between the French and Dutch Governments in the seventeenth century.

The reclaiming of salt from the great salt ponds of St. Martin has long been a government monopoly, and the industry is worked under government concessions. The amount and value of the salt exported in the past few years from St. Martin are shown in the following table:—

Exports of Salt from St. Martin in the years 1930, 1931, 1932 and nine months of 1933.

Year.	Barrels of 115 Kilos.	Value at one Guilder per barrel. In Pounds.		
		£	s.	d.
1930	25,800	2,150	0	0
1931	24,000	2,000	0	0
1932	51,000	4,250	0	0
1933 (nine months)	26,500	2,208	0	0

The nature and value of the chief exports from St. Eustatius are shown in the next table.

The Principal Exports from St. Eustatius during the the 10-year period, 1913-1922.

Exports.	Mean Annual Value. In Guilders.	In Pounds.		
		£	s.	d.
Cotton	36,000	3,000	0	0
Sweet Potatoes ..	2,000	167	0	0
Yams	3,770	317	0	0
Stock ..	3,954	328	0	0
Charcoal ..	95	8	0	0

A small amount of sisal fibre was produced and exported from St. Eustatius during a short period, but the industry came to an end in 1927 or 1928. English potatoes have been exported in small quantities from Saba during recent years.

(VI) Needlework Exports from Saba.

The receipts for the sale of needlework, as recorded at the local Post Office, may be taken to represent the value of the exports from the island. They may also include remittances other than for the sale of fancy work, but it is estimated that sales paid for through other channels more or less balance these other remittances.

Year.	fl.	In Pounds.		
		£	s.	d.
1925	21,310	1,776	0	0
1926	17,240	1,437	0	0
1927 ..	13,670	1,139	0	0
1928	13,560	1,130	0	0
1929	14,770	1,231	0	0
1930	11,000	917	0	0
1931	10,000	834	0	0
1932	3,905	425	0	0
1933 (nine months)	950	79	0	0

(VII) Present and Future Outlook.

The Dutch Leeward Islands have not escaped the effects of the world depression. The opportunities for seasonal occupation on the sugar plantations in the Greater Antilles unfortunately have ceased. Remittances from friends and relations abroad have been greatly reduced, and, in the case of Saba, the sales of fancy work have seriously diminished. There is no agricultural employment for which wages are paid in any of these islands. In spite of these facts, the general appearance of well-being and prosperity is very remarkable. The people assiduously cultivate their gardens and produce a very considerable part of their food requirements, although a good deal of tinned and preserved foods and bread is imported.

The appearance of the villages is particularly attractive. The houses are well painted and kept in good repair, and streets and lanes are clean and tidy. In each of the islands there are a radio station, a hospital with resident doctor, free schools, a public library and churches receiving government grants-in-aid. There is a small but efficient police force in each island.

The fortnightly steamer services of the Dutch Royal Mail are subsidized by the Government. There are no taxes in the Dutch Leeward Islands, except an annual dog tax. The import duties are very low, the standard rate being 3 per cent. *ad valorem*, with somewhat higher specific duties in the case of certain commodities. The local Administrative Officer is assisted in each island by two local councillors, and the islands are visited from time to time by the Governor, the Judge, and other Colonial Officers from Curaçao. There are no hotels, and visiting officials have to be accommodated in the Government Guest Houses.

The Dutch Leeward Islands are of particular interest in that they instance the consideration and benefits conferred on dependent communities by a paternal central government. The excess of cost of administration over revenue must be considerable, but the established principal of Dutch Colonial Government, namely, that there shall be no taxes and a minimum of import duties, still persists.

FRUIT PRESERVATION.

The preservation by heat of fruit in bottles and cans aims at retaining indefinitely the natural colour, flavour and form of the fruits, in other words, presenting the consumer with a preserved product resembling the fresh article as closely as possible. The achievement of this end in commercial practice is extremely difficult, and numerous problems have had to be solved to obtain the present high standard of heat-preserved fruits. Improvements in the container have to a large extent contributed to the retention of the natural fruit colour; modern technique has helped with the problem of flavour, but considerable difficulty in control is still experienced in maintaining the natural form of the fruit. Although softening of the fruit tissues is, to some extent, necessary for a palatable product, excessive softening, resulting in disintegration, is from every point of view undesirable. Such disintegration, either partial or complete, may in general be due to physical, chemical or to micro-biological causes. Under the first heading may be included the use of an unsuitable variety (or of over-ripe fruit) the structure of which is easily damaged by heat. Faulty packing and lack of control of either time or temperature, resulting in over-cooking are also causes of softening.

A similar effect, although less intense in character, results from hydrogen production in the cans. In this "half-blown" or "hydrogen swell" condition, pressure in the can is the result of hydrogen generation by the complex interaction of contents and container. In cases where the fruit has a tendency towards softness, such gas production causes at least partial disintegration.

These chemical and physical effects are controlled only with difficulty, when fruit is being preserved on a large scale. They have therefore been given more attention than the micro-biological factors, which up to the present have been considered more easily controllable.

Normal processing times and temperatures in conjunction with the high natural acidity of the fruit readily destroy bacteria, while yeasts and moulds, being usually less resistant to heat, are al o killed. It has therefore been assumed that sterile packs could be obtained with little or no difficulty under conditions of processing suitable for producing well-cooked yet unbroken fruit. The presence of living micro-organisms in processed fruits is, in consequence, more generally attributed either to inadequate processing or to faulty closure. Further, strain in processing and in cooling cans may produce minute (sometimes only temporary) holes, and these are recognised means of entry of micro-organisms. In cases where from such causes living yeasts are present, metabolism is accompanied by gas production, the pressure of which finally bursts the container and the fruit becomes disintegrated—the condition known commercially as "blown."—(Taken from an article by M. Olliver and T. Rendle. *Journ. Soc. Chem. Indus.*, 1934, p. 166 T.) F. H.

REVIEW.

TERMITES AND TERMITE CONTROL, A REPORT TO THE TERMITE INVESTIGATIONS COMMITTEE.

By Charles A. Kofoid (*Editor-in-Chief*), S. F. Light, Merle Randall and others. Berkeley, California: *University of California Press*, and London: *Cambridge University Press*, 1934. pp. XXV+734, 182 figs. Price 22*s*. 6*d*.

This large and extremely valuable work is a report to the Termite Investigations Committee, organised in California in 1927 in an attempt to reduce the tremendous damage caused by these insects (which are named "white ants" in popular, unfortunately incorrect, language). The Committee received its financial support chiefly from commercial companies concerned in the production and use of wood, and much of the work and its direction was done by members of the University of California, with Professor C. A. Kofoid, of the Zoology Department, as Chairman of the Advisory Council. The results are a fine example of co-operation—to mutual advantage—of science and industry. The investigations were very extensive and varied (there is even a chapter in the book on the pH in termites' intestines) and, while they are designed primarily to solve problems in North America, most of them are of a fundamental nature, with results that will find a wide application. The researches undertaken in California for the Committee, together with contributions from some American scientists in other places, are described by no less than 34 authors, each an expert on some aspect of the termite problem.

Part I contains extensive discussions on almost all features of termites in general, their ways of living and the damage they do; a review of the fifty-five species that constitute the known termite fauna of the United States, with very detailed accounts of some of them; and short chapters on the termites of the Hawaiian and Philippines Islands, the West Indies and the Panama Canal Zone. The largest contributions to this extremely interesting section are those of Professor S. F. Light, of the Zoology Department of the University of California, who is an authority on termites and their habits. In a chapter on "Termites and Growing Plants" he describes the habits of four species that sometimes eat living plant tissues. He states that in temperate countries damage to crops is sporadic and of minor economic importance, though in the tropics termites cause considerable losses in tea, rubber and teak, and to a less extent in sugar-cane, cacao, coffee and citrus fruits.

Part II—"Chemical Investigations" to which Professor Merle Randall of the University of California contributes largely—gives the results of experiments to test the toxicity and general efficacy against termites of an immense number of solids, liquids and gases, including many commercial proprietary preparations. A large number of chemicals and methods in use were found to be of little value. Many of the liquids used in the preventive treatment of wood, however, give a large measure of success. The best method for killing termites of dry wood is the introduction of poison dusts, such as Paris Green, into their galleries. The subject of chemical control is full of great practical difficulties, and many of the necessary tests are admittedly inconclusive as regards use on a large scale, unless they are continued for many years. The Committee cannot therefore be reproached if it has not immediately solved all the problems of chemical control—it is to be congratulated on presenting a great volume of sound experimental results.

Part III deals with the resistance of many kinds of wood and other substances to termite attack and the results of tests made. New methods of determining degrees of resistance are described. Termites are highly selective in their choice of food, but the use of woods that happen to be avoided by them is unfortunately limited.

In Part IV—"Prevention and Repair of Termite Damage"—there are authoritative and detailed recommendations, illustrated like the rest of the book by excellent drawings and photographs, for architects, builders, householders, timber merchants, legislators, and many others. Many of the methods advocated lead to almost certain success, often at high but not excessive costs; in others there are difficulties yet to be surmounted. The counsels given in this book should be of inestimable value in all countries where termites are injurious: that is, throughout the tropics and subtropics and in some temperate regions.

Profits from the sale of the book will be devoted to further researches. It is greatly to be hoped that they will be continued for a long time.

A. M. A.

OBITUARY.

MR. G. N. K. TURNBULL.

IT is with deep regret that we have learnt of the death at the age of 29 of Mr. G. N. K. Turnbull who joined the College as a Colonial Office Scholar in October 1927. Turnbull, who was educated at Dover College, and Glasgow University distinguished himself here both in the fields of work and sport. He will chiefly be remembered by his pleasant personality which made him one of the most popular students of his year. When he died he was attached to the Nigerian Department of Agriculture as Superintendent of Agriculture.

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Canning Grapefruit.

An illustrated article on this subject is published in the August, 1934, issue of *Industrial and Engineering Chemistry*, p. 823. It was written by A. E. Stevenson, of the Continental Can Company of Chicago. The sizes of fruit used for canning in No. 2 cans are 54, 64 and 70. The peel is either removed by hand by means of sharp knives, or by immersing the fruits in a boiling, dilute solution (2 per cent.) of soda-lye, for 10 or 15 seconds. The fruits after the lye treatment are thoroughly washed by sprays of water, and the segments separated by means of a blunt knife. The segments are then carefully filled by hand into the cans. No suitable machine for performing this operation satisfactorily has yet been devised. Sufficient syrup (17° Brix) or sugar and water is next added to fill the spaces, and the cans are then evacuated either by heating their contents to 180°F for 25 to 30 minutes and sealing, or by a special vacuum-closing machine. In either case, the contents are sterilised at 180° to 190° F in a hot water bath, the main object being to destroy yeast cells which are the chief contaminating organisms causing spoilage. The cans are quickly cooled and stored at relatively low temperature. One pound of canned fruit is obtained from three pounds of fresh whole fruit. Canned grapefruit juice contains some suspended pulp, and is sweetened by addition of sugar. It is prepared from the smaller sizes of good quality fruit. The fruits are cut in halves and reamed or burred on revolving corrugated cones, care being taken to avoid contamination of the juice with rind oil. The juice is screened to remove seeds and large pieces of pulp, the latter being beaten up so as to cause them to pass through the screen. It is then sterilised or pasteurised by one of four available methods, and filled into the cans so as to leave no space for air, which would bring about undesirable oxidation changes. Finally, the full cans are rapidly cooled before storing.

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Bentonite in Fungicide Mixtures.

Bentonite colloidal clay, mixed with sulphur, yields a valuable fungicide, which is stable, innocuous to the plant, very toxic to most disease organisms of plants, and highly adhesive to plant surfaces. It is made by mixing finely-ground dry Bentonite with finely-ground sulphur, in the proportion of two to one. The mixture is passed through steam-heated screw conveyors, which causes the clay to take up the sulphur. The product forms stable suspensions in water, and the size of the suspended sulphur particles is very small. It is superior to lime-sulphur mixtures; actual field trials and laboratory tests by spore-count methods, prove that it is a very effective agent for destroying fungi causing plant diseases. —(*Journ. Soc. Chem. Indus., Abstracts 'B,'* 1934, p. 418.)

Alcohol Motor Fuel in the Philippines.

In the Philippines, mixtures of alcohol, gasoline and benzol and of absolute alcohol and gasoline have been tried, and found almost as satisfactory as straight gasoline; but the difference in retail price has not been sufficient to bring them into general use. In that country the cheapest and largest-used motor fuel is just 94.95 volume per cent. alcohol with only one per cent. of gasoline as denaturant, which simple formula has been permitted through the co-operation of the Bureau of Inland Revenue. This fuel sells for about 20 centavos ($0.10 United States currency) per United States gallon, less than half the price of gasoline. At ordinary tropical temperatures it gives no trouble in starting. Some of the Centrals in the Philippine Islands with distilleries attached have found it profitable to discard old steam locomotives and replace them with internal combustion engines. For such purposes absolute alcohol has no particular advantage over the 94 per cent. spirit, since the latter is perfectly miscible when only small percentages of alcohol are required.—(*Inter. Sugar Jour.*, Vol. XXXVI, No. 426, 1934, p. 246.)

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Vitamin D in Cacao Shell.

The Analyst for July, 1934, contains a paper by Mr. A. W. Knapp, chief chemist of Messrs. Cadbury, and Miss K. C. Coward, which describes tests on rachitic rats fed with cacao shell added to an otherwise vitamin-free diet. The results showed that cacao *shell* contains an unusually large quantity of the anti-rachitic vitamin D, amounting to 28 units per gram. Previous tests with cacao *nib* demonstrated that this material contains only one unit of vitamin D per gram. Cod-liver oil was used as standard; its content of vitamin D is taken as 100 units per gram. For a vegetable product, cacao shell therefore possesses very pronounced anti-rachitic properties. It is interesting to speculate to what extent the production of vitamin D in cacao beans is due to their long exposure to tropical sunlight during the sun-drying process practised on most plantations. It is known, for instance, that native produced palm oil has a higher anti-rachitic potency than plantation palm oil, and this difference is usually attributed to its greater exposure to sunlight. Yeast cells become strongly activated in strong light, and fermented cacao beans are freely contaminated with yeast, which may be the real agents responsible for vitamin production in the beans.

The shell of fermented cacao contains between one and two per cent. of fat. During roasting, some of the fat from the nib passes outwards into the shell whose content of fat may thus be raised to three per cent. of its weight. It is probable that most of the vitamin D of cacao is concentrated in the fat component, which must therefore possess extremely high anti-rachitic potency.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

The Practical Exhaustibility of Java Molasses. *C. Sijlmans.*

The author observes that the question of the exhaustibility of molasses has been thoroughly studied so far as laboratory investigations can carry the subject. This indispensable work now needs to be completed by a definite settlement of the question of the extent to which the composition of the non-sugars is the critical factor in controlling the exhaustion of molasses attainable in practice. This is best done by a statistical analysis of data from practice and the present monograph represents such an analysis. Among conclusions reached are the following:

In molasses where sucrose and water are in equilibrium (saturation coeff. = 1.00) the ash concentration puts a limit on non-sugar concentration. The ash concentration attainable in practice is dependent on the ash content of the non-sugar and the temperature of purging. The so-called optimal ash concentration can be calculated with sufficient accuracy by the formula:

$$G_2 = 1.6665G_1 + 0.9946G_3 - 3.392$$

wherein G_2 = optimal ash concentration, G_1 = sulphate ash % true non-sugar, G_3 = Centigrade temperature of purging.

The optimal ash concentration gives the quantity of ash per cent. water, which will characterize a molasses as one that can be satisfactorily exhausted at a given content of ash per cent. non-sugar at the purging temperature. The ratio of ash per cent. water in a saturated molasses, and the calculated optimal ash per cent. water, is called the corrected ash concentration quotient. The higher this quotient, the better the exhaustion will be. The normal exhaustibility of a molasses in practice is exclusively dependent on the optimal ash concentration and on the solubility of sucrose, which means the quantity of ash and of reducing sugar.

The so-called "practical exhaustibility" can be calculated with sufficient accuracy by the formula

$$X_1 = 50.0723 + 0.30615X_2 - 0.09789X_3$$

wherein X_1 = calculated sucrose per cent. true non-sugar, X_2 = ash per cent. glucose-free organic non-sugar, and X_3 = reducing sugar per cent. glucose-free organic non-sugar. The ratio of sucrose per cent. true non-sugar in the molasses and the calculated quantity of the same is called the quotient of exhaustibility; it is practically exclusively dependent on the corrected ash concentration quotient and has the same numerical value.

The practical measures to be taken to secure a better exhaustion can be inferred from the corrected (or uncorrected) ash concentration quotient and the saturation coefficient. The centrifugability of melassecuites is largely dependent on the saturation coefficient; the cuite should be either diluted or warmed until the saturation coefficient = 1.00. Warming up is preferable to dilution.

As the most recommendable method of handling melassecuites the author gives the following: Discharge the cuite as near as possible at an uncorrected ash concentration quotient of 1.00 (corresponding to the temperature of dumping); let it ripen in the mixer until the corrected ash concentration quotient reaches at least 1.00, and centrifuge at this temperature. Adjusting the ash concentration to the optimal concentration is easily done by making electrometric ash determinations. In all calculations of Winter rendement the practical exhaustibility should be inserted in the formula, and not, as heretofore, be regarded as a constant. For making all calculations on exhaustibility it is sufficient to know the brix, sucrose, reducing sugar and ash. For calculating the corrected ash quotient the temperature of purging must be known; for calculation of the saturation coefficient the uncorrected ash quotient and the brix of the undiluted molasses are necessary.—(*Facts About Sugar*, Vol. XXIX, No. 10, 1934, pp. 368-69.)

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Dextro-Rotary Substance in Bagasse. *E. P. Hedley & F. W. Hayes.*

An investigation is reported, the results of which tend to show that a substance showing optical rotary powers is extracted from apparently sucrose-free bagasse. This substance gives every indication of being a pentose sugar, probably xylose. This shows that in the existing method of bagasse analysis, where the substance is boiled with water, some substance other than sucrose is extracted or produced by hydrolysis and affects the polarization. According to the authors, little help is to be expected from Haddon's "baryta" method in the way of preventing hydrolysis or in eliminating the pentose sugars formed. This again raises the question as to what is to be known as "cane fibre." In this connection both the definition of fibre and the method of bagasse analysis, as recommended by the Committee on Uniformity in Reporting Factory Data of the International Society, would seem to merit further investigation and discussion. —(*Facts About Sugar*, Vol. XXIX, No. 10, 1934, pp. 369.)

FOR SALE.

First Annual Report on Cacao Research, 1931, 44 pp. 1 plate. *Price* 1s.

Second Annual Report on Cacao Research, 1932, 40 pp. 4 plates. 34 figs. *Price* 5s.

Third Annual Report on Cacao Research, 1933, 72 pp. 3 plates, 4 diagrams. *Price* 5s.

To be obtained from the Editor *Tropical Agriculture*, Imperial College of Tropical Agriculture, Trinidad, B.W.I.

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—Prices on the Home Markets have ranged as follows (c.i.f. per cwt.)

	Foreign.		*Preferential.*	
	s.	*d.*	*s.*	*d.*
27th September	4	5¼	8	2¼
4th October	4	5¼	8	4½
11th October	4	5¼	8	4½
18th October	4	5¼	8	2¼
25th October	4	1½	7	9½
1st November	4	0	7	9
8th November	4	0¾	7	9¾
15th November	3	11¼	7	8¼
(16*th Nov.*, 1933)	5	1½	9	0

Dull conditions have predominated in the market with values showing a tendency to sag. The market has been for some time in a nervous condition, brought about chiefly by moderate offerings of first hand sugars in the face of only a very limited interest. The American market is also in a nervous state because Cuba still has a considerable quantity of sugar to ship if she is to fulfil her 1934 quota. With consumption in the United States of America failing to reach the level required by the quotas it has been obvious for some time that an awkward situation would develop towards the end of the year.

* * *

COCOA.—Recent cable advices from London state that the farmers on the Gold Coast are definitely holding back supplies and on this account the market remains firm but inactive. It is problematical whether such policy will, in the long run, prove effective, unless the farmers are prepared to destroy surplus supplies should they ultimately find it impossible to market their supplies. On the other hand, actual stocks of cocoa in New York are distinctly low, and if the long position on the New York Cocoa Exchange for December is handled with discretion prices are likely to be maintained. Much will depend on the result of the factors mentioned above. Good fermented Accra to arrive is quoted at 19*s.* 9*d.* c.i.f. and Plantation Cocoa is quoted locally at $6.60 a fanega.—(*By Courtesy of the Cocoa Planters' Association of Trinidad.*)

* * *

COFFEE.—The market has generally been quiet with substantial declines on previous values, the outlook for the immediate future being very uncertain. Quotations for Costa Rica, good to fine, first size 95*s.* to 130*s.*, Jamaica, ordinary to good 55*s.* to 57*s.* Kenya ordinary 55*s.* to 60*s.*

* * *

BANANAS continue in fair demand with the price of Jamaicas 10*s.* per ton higher at £17 5*s.* delivered London or £17 nearest station Provinces. Brazilians are quoted at £18 nearest station.—(*West India Committee Circular*, 25th October.)

RUBBER.—Quotations for Plantation Sheet have ranged as follows:—

	d.
26th September	7 7-16
3rd October	6 15-16
10th October	7
17th October	6 15-16
24th October	6 7-8
31st October	6 7-16
7th November	6 7-16
14th November	6 3-8
(15*th Nov.*, 1933)	4 1-8

There has generally been a slight falling off in values chiefly brought about by weakness on Wall Street and in the American commodity markets. The market has been awaiting the decision of the International Rubber Regulation Committee on the permissible percentage of exports for the early months of next year. Permissible exports have been fixed at 80 per cent. for November and 70 per cent. for December. Consumption figures for September at 30,352 tons are well above market expectations.

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COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association.

	American Mid.	*Egyptian F.G.F. Sakel.*
28th September	6.91	8.41
5th October	6.88	8.02
12th October	6.96	8.10
19th October	6.97	8.33
26th October	6.92	8.22
2nd November	6.79	—
9th November	6.81	—
(10*th Nov.*, 1933)	5.31	7.10

Prices of American have generally fluctuated within narrow limits. Speculative interest has been at a low ebb, and most operators are awaiting for further developments relating to the policy of the American Government. There has, however, been some active demand for outside growths. West Indian Sea Island has been quoted at from 12*d.* to 15*d.*

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COPRA is quietly steady with West Indian f.m.s. unchanged at £9 12*s.* 6*d.* c.i.f. London.—(*West India Committee Circular*, 25th October.)

* * *

LIME PRODUCTS.—*Lime Oil.* Handpressed is valued nominally at 32*s.* 6*d.* per lb. There are sellers of Distilled at 20*s.* on the spot and at rather less for forward, but the demand is slow. *Lime Juice.*—There are buyers of Concentrated at £4 15*s.* No sales of Raw have been reported. The value is nominally 2*s.* 3*d.* to 2*s.* 6*d.*—(*West India Committee Circular*, 25th October.)